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Some "ancient" history here

UF_6 CONTAINMENT STUDIES: CONTROLLED RELEASES IN GAT ENVIRONMENTAL CHAMBER

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Uranium Hexafluoride - Releases
Uranium Hexafluoride-Cloud Formation
Uranium Hexafluoride-Containment Studies

ABSTRACT

Releases of gaseous UF_6 into static atmosphere at ambient environmental chamber test conditions with relative humidities varying from of 9-90% and temperatures of covering range 0^{o}-$40^{o}C$, have shown that changes in temperature and humidity do not significantly affect UO_2F_2 particle size formation (1-3 micron diameter) or the slow release cloud settling time (0.1 mm/second). Typical gas release particulate clouds have been studied using sequential photographs and motion pictures.

The second stage of study, which involves gas release into dynamic airflow, is now underway. Experiments involving simulated liquid UF_6 container rupture, spill size exceeding the available UF_6/moisture hydrolysis capacity, and various cloud knockdown techniques are currently in the planning stages.

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INTRODUCTION

One the of recommendations of the Three-Plant UF_6 Cylinder Handling Committee was that experimental studies be made to evaluate different procedures and methods for use in the containment of UF_6 releases.[1] Subsequent to this recommendation, a three-plant committee of development personnel determined that there was a need for basic development effort to evaluate UF_6 containment methods, and to provide design information for UF_6 containment systems.[2] UCCND-Paducah was assigned the responsibility of evaluating scrubbers to remove airborne UF_6 release products. A concurrent GAT line item technical support plan cited the following objective: "to test presently used methods of containing a UF_6 release and develop, if needed, alternative methods of containment." Included in this general objective are the following specific objectives: (1) characterize the reaction between UF_6 and water; (2) determine the effects of environmental conditions of UF_6 cloud formation and eventual fate; (3) analyze the effects of water and/or steam sprays for UF_6 containment and recovery with special emphasis placed on nuclear safety; (4) evaluate other proposed containment methods (e.g., carbon dioxide, non-aqueous solvents, other chemical treatments); and (5) determine the best methods of recovery or disposal of products resulting from containment efforts.[3]

Having completed phase one, UF_6 gas release tests into static atmospheres, the work is currently into phase two study of UF_6 releases into dynamic atmospheric conditions simulating wind effects on UO_2F_2 cloud dispersal. Releases simulating liquid UF_6 container rupture, spill sizes exceeding available UF_6/moisture hydrolysis capacity, and cloud knockdown experiments will follow.

ENVIRONMENTAL CHAMBER

A technical support project, "UF_6 Containment Studies," was approved on April 2, 1975. GAT representative made trips to Edgewood Arsenal, Maryland, and Baton Rouge, Louisiana to evaluate environmental chamber designs and to discuss operational problems. After numerous shipping delays, complicated by train wreck damage enroute, the enclosure was received from Scientific Systems of Baton Rouge, in late 1978. Assembly and testing were completed by April of 1979. Figure 1 is an overall view of the containment chamber as it appears today. The interior dimensions are nine feet by sixteen feet by eight feet high, giving an approximate volume of 1,160 cubic feet. The air handling system is capable of controlling temperature and humidity (dew point) independently in the range of -5 to 45°C controllable to within ±0.4°C. Within these temperature-humidity ranges (near zero to 100% relative humidity), any climatic conditions anticipated for a plant location can be simulated. Observation windows are located in the sides, the door, and the top of the chamber. Sealed fluorescent lights provide interior illumination. The air handling unit is protected

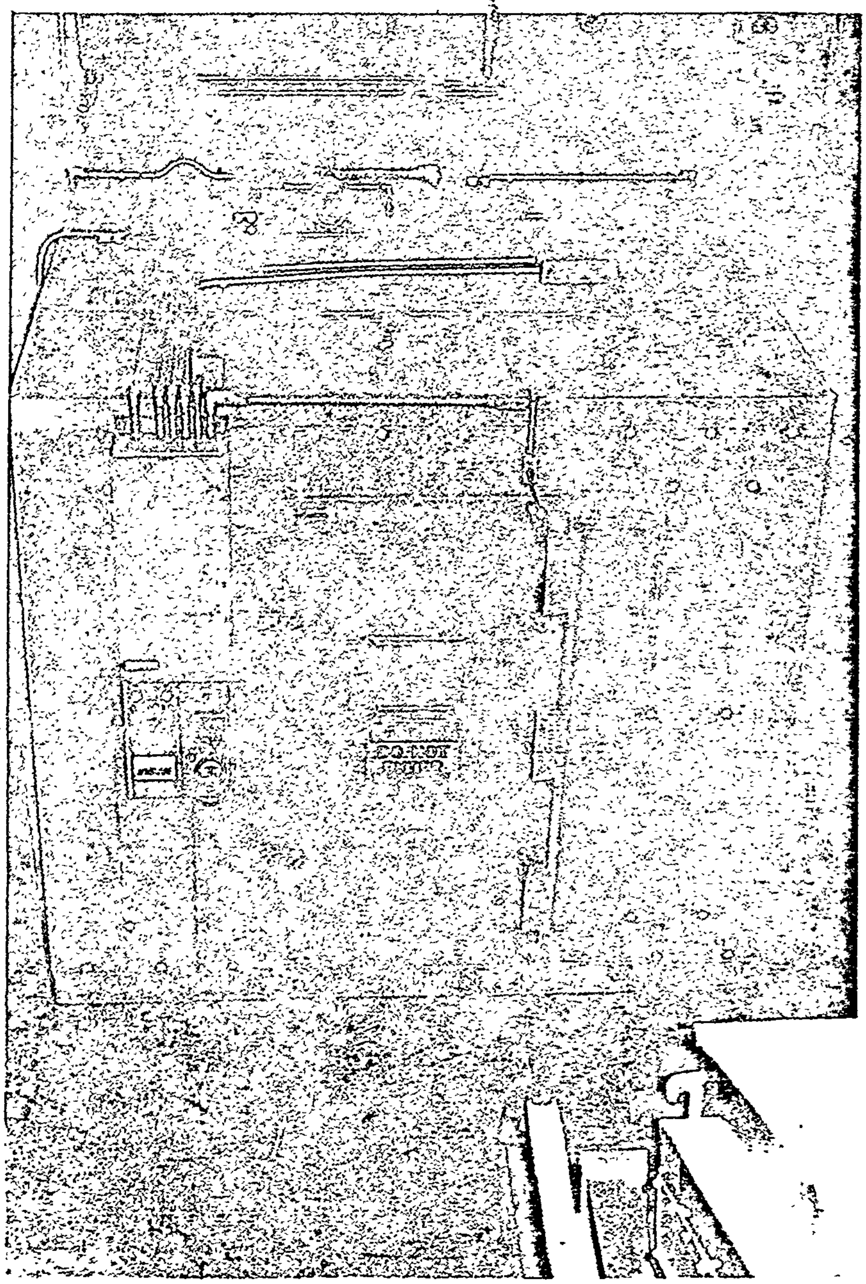

FIGURE 1 UF_6 CONTAINMENT CHAMBER

from contamination by the use of activated carbon and HEPA filters. All interior surfaces are constructed either of Type 304 stainless or of plexiglass for corrosion resistance. Decontamination is accomplished by pumping solution from a 50 gallon reservoir through a rotating spray nozzle mounted in the chamber ceiling. Figure 2 shows the decontaminating spray head inside the chamber. This spray system readily cleans interior chamber surfaces to background count.[4] Releases that are smaller than 20g tails assay UF_6 are flushed with 40-50 gallons of water to a neutralization pit having a limestone leach bed. Decontamination solutions from larger releases are pumped to drum storage and transferred to X-705 uranium recovery operations.

EXPERIMENTAL

Following a tails assay UF_6 release, samples of the resulting hydrolysis cloud are obtained at predetermined times on nucleopore filters housed and protected in plexiglass sampling boxes located inside the chamber. Sample box lids are vacuum operated, and controlled from outside the containment chamber. Figure 3A shows the sample boxes, while Figure 3B shows the box lids in the activated and deactivated states. After decontamination of the interior of the chamber, the filters are removed from their protective sampling boxes for particle size and composition analysis by scanning electron microscopy.

The first recorded release for which data were obtained, took place on May 10, 1979. 1.8 grams of UF_6 were released into the chamber with an air temperature of 22°C and a dew point of -2°C. This gives a relative humidity of about 20%. Samples were taken of the resulting particulate, and it was noted that the major portion of the particulate matter was in the 0.81 to 1.10 micron range. In eleven releases which have followed, we have found this general range of results to be representative. A number of these releases have been photographed both in still and motion pictures.

Figure 4 is a composite print of 35 mm stills, photographed in real time at a rate of 1 exposure per second. A layering effect, or stratification of the cloud, can be seen. It is most evident in later exposures of the sequence.

RESULTS

Twelve releases have been recorded, ranging in mass from just under two grams to just over 20 grams tails assay UF_6, into static atmospheric conditions with temperatures between 15° and 40°C, and dew points from -2° to 30°C. There were no significant differences found in the UO_2F_2 particle size formation (1-3 microns in diameter), or in release cloud settling rates (0.1 mm/sec.). Figure 5 is a representative bar graph indicating percent distribution vs. UO_2F_2 particle

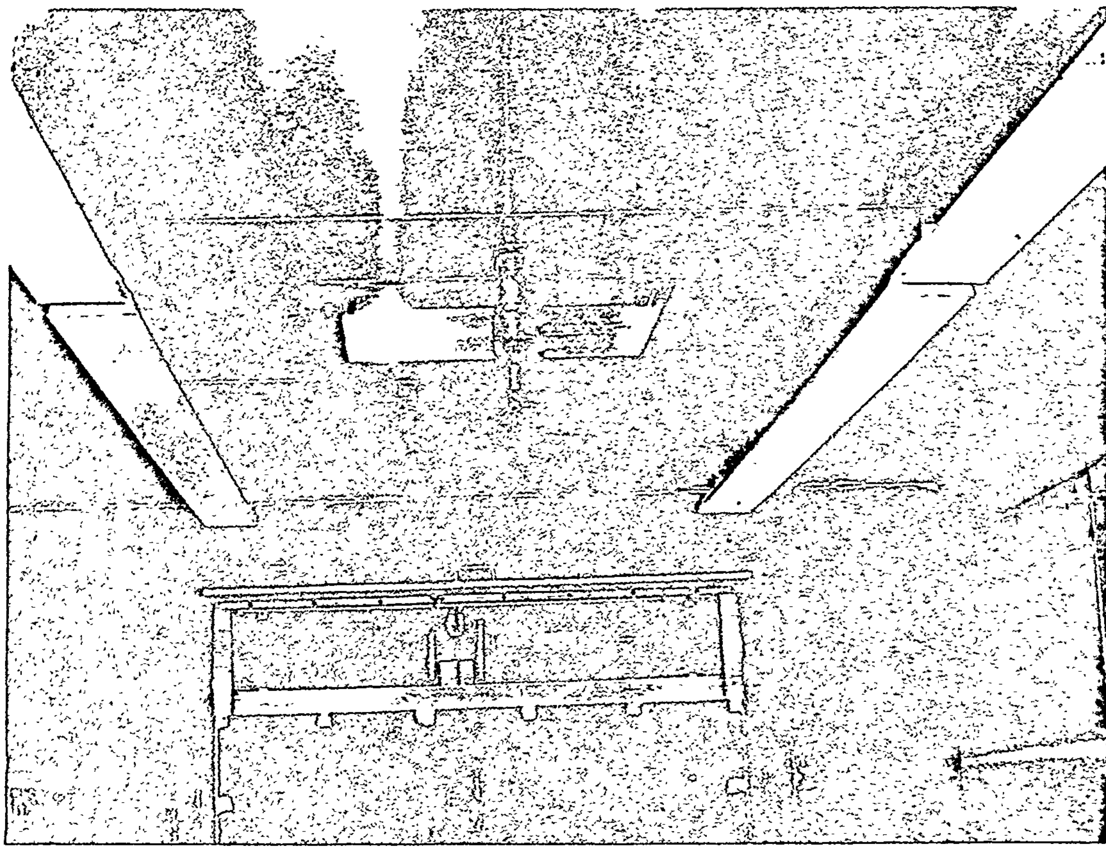

FIGURE 2 DECONTAMINATING SPRAY HEAD

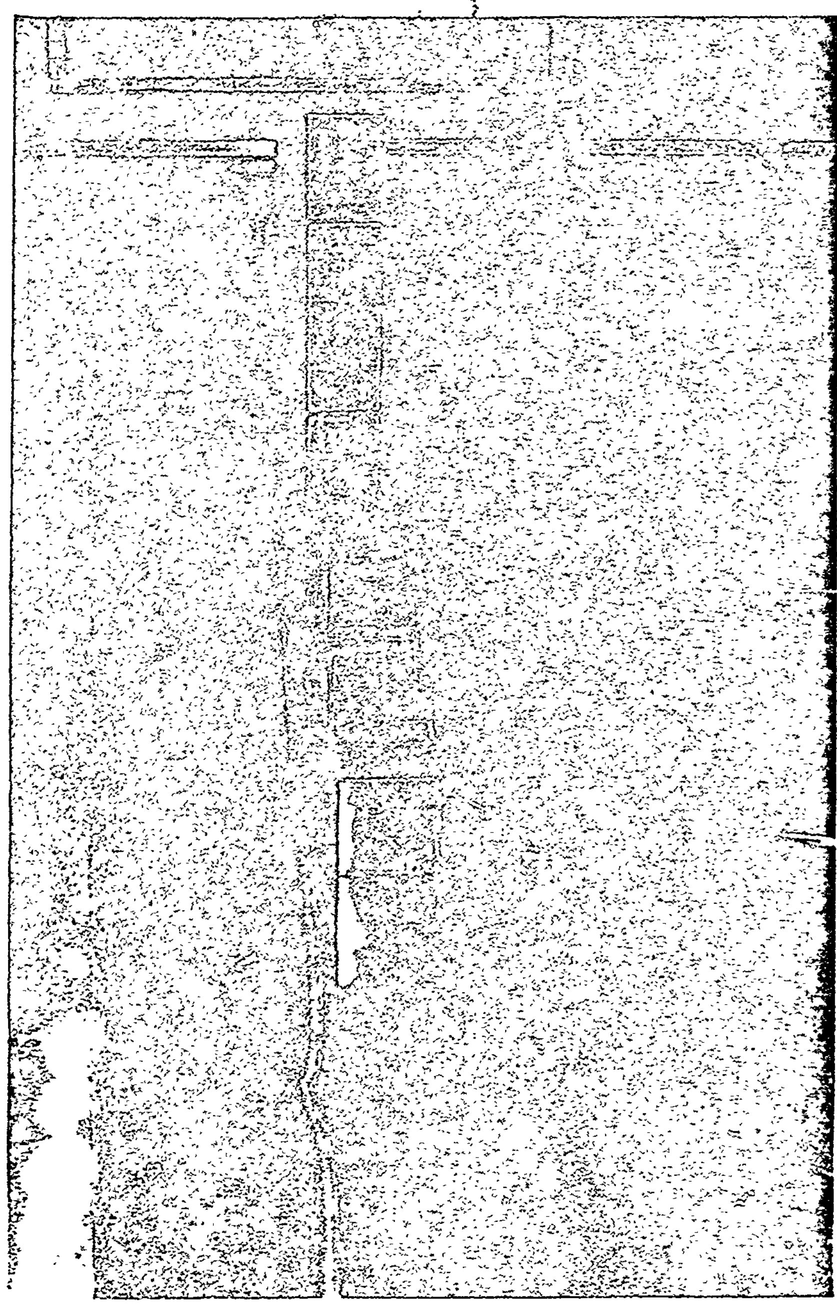

FIGURE 3A GAS RELEASE BOX (TOP)
AND SAMPLE COLLECTORS (CENTER)

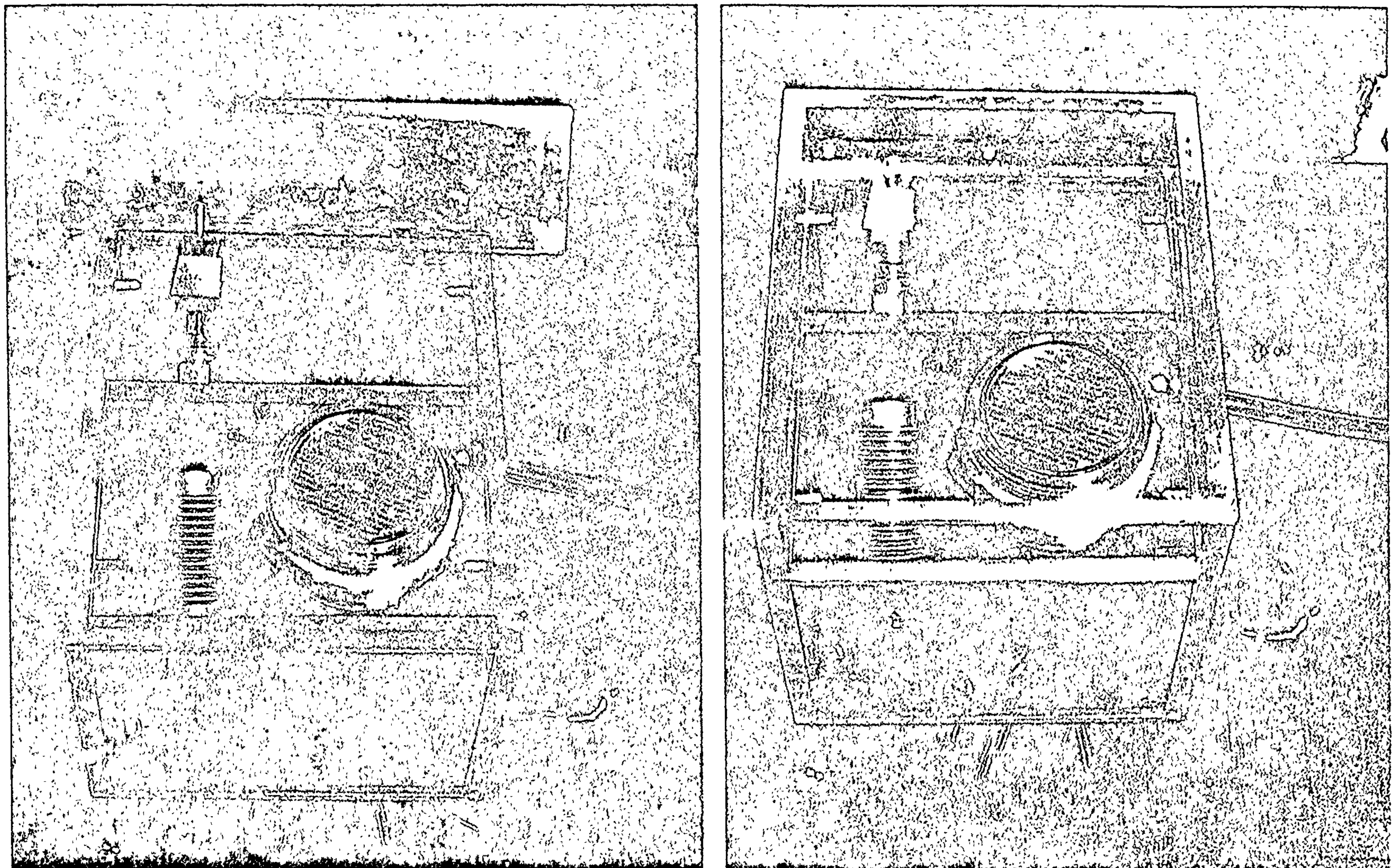

FIGURE 3B PARTICULATE SAMPLING DEVICE OPEN (LEFT) CLOSED (RIGHT)

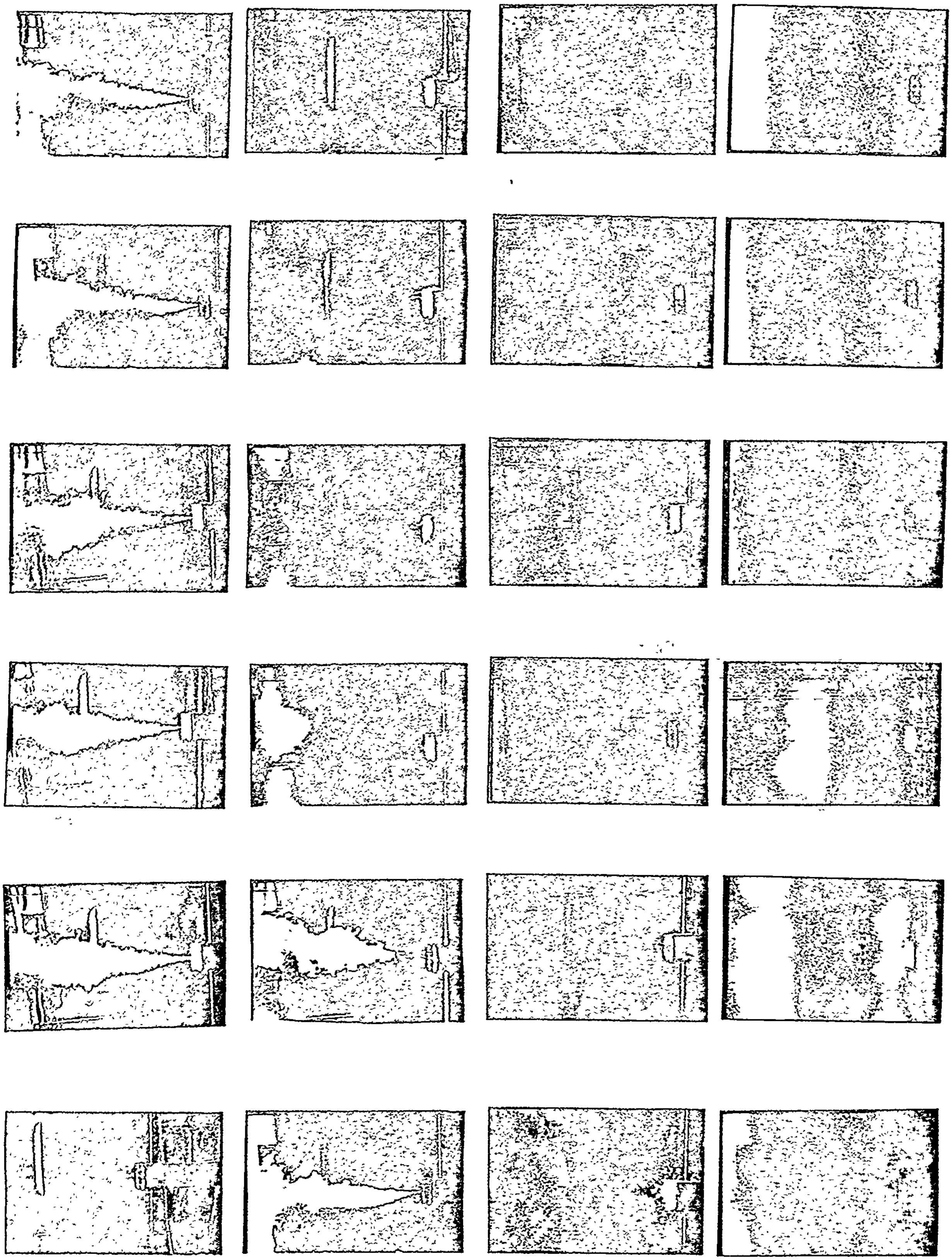

FIGURE 4 UF_6 CLOUD FORMATION

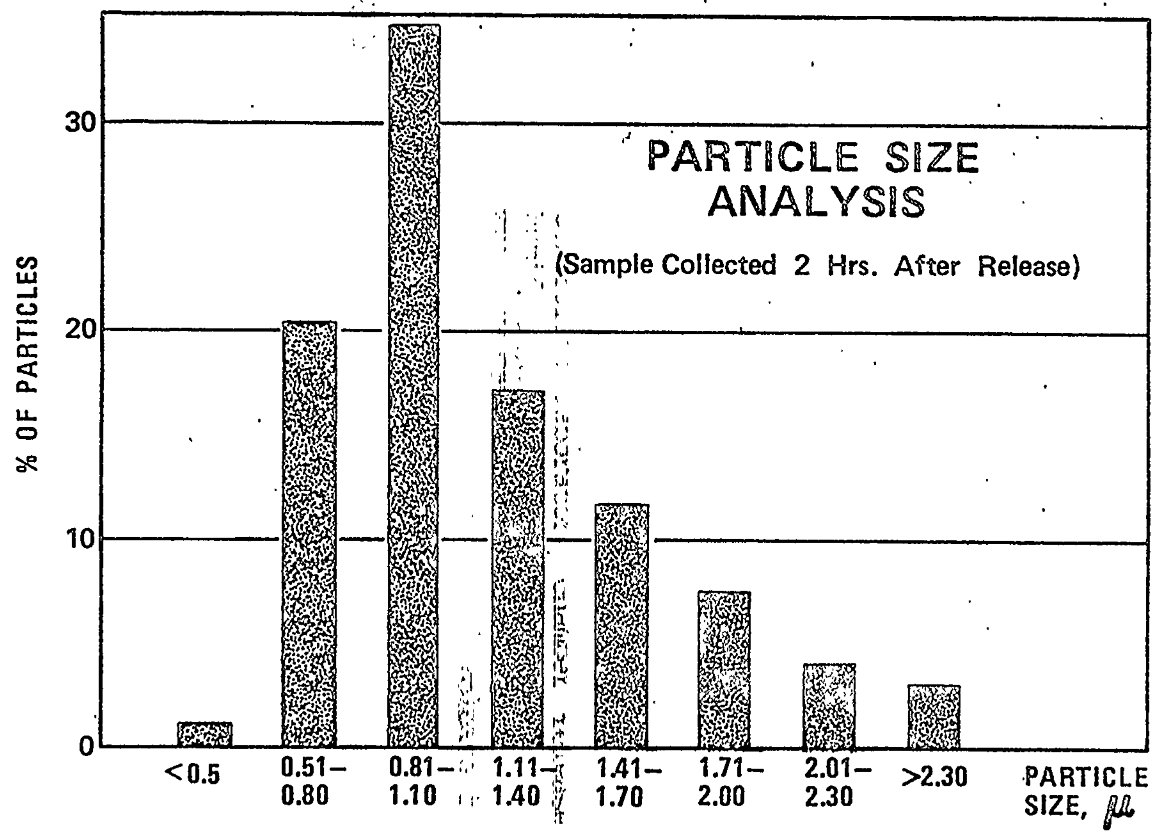

FIGURE 5 DISTRIBUTION OF PARTICLE SIZES

size. Very little difference was noted between particle size distribution results of the individual releases.

WORK IN PROGRESS

Work on the UF_6 containment project is currently directed toward studying the release of UF_6 into dynamic air flows. Installation of blowers, and air deflectors to establish the desired laminar type of air flow has been completed. "Wind" speeds of about 2 mph can be obtained. Smoke made up of ethylene diamine and acetic acid was used to observe particular air flow patterns prior to releasing UF_6. The smoke indicates air flow turbulence paths but does not necessitate decontamination before entering to adjust equipment. Operational evaluation of Pyr-A-Larms and alpha-air samples are now underway. The mathematical model for the UO_2F_2 plume dispersal studies being assembled by Battelle will be run concurrently with data from our studies on turbulence/laminar flow effects.

FUTURE WORK

As work progresses on the dynamic atmosphere UF_6 release studies, plans are being made to investigate "Zero Humidity" conditions, i.e., releases of UF_6 amounts in excess of available UF_6/Hydrolysis capacity. Need for such data was brought into focus in a recent controlled laboratory chamber release of small volume at ultra low humidity (0.05%), in which no visible UO_2F_2 cloud was formed. Liquid spill releases are also planned, and procedures for real time sampling of the atmosphere during a release by means of mass spectrometry are now being prepared. Cloud knockdown techniques, the ultimate project goal will be to evaluate the relative efficiencies of water or steam spray, fog, CO_2, and other chemical means which have not been devised at this time.

First phase testing, involving UF_6 gas releases into static atmospheres, under ambient conditions normally found in the gaseous diffusion plants, have indicated that between 9-90% relative humidity, and between 0-40°C, temperature and humidity effects do not significantly affect UO_2F_2 particle size formation (1-3 micron diameter), or release cloud settling rates (0.1 mm/sec.).[5]

REFERENCES

1. UF_6 Cylinder Handling Committee Report: Containment, September 20, 1974.

2. W. R. Golliher, "Development Work on UF_6 Containment," Letter to H. E. Trammell, January 31, 1975.

3. Technical Division Project Plan, UF$_6$ Containment Studies, Goodyear Atomic Corporation, Piketon, Ohio, April 2, 1975.

4. D. L. Williams, and S. W. Wohlfort, Personal Communication, to E. O. Sternberg, GAT-521-79-155, Goodyear Atomic Corporation, Piketon, Ohio, August 7, 1979.

5. S. W. Wohlfort, Process Technology - Mission IV Bimonthly Project Reviews (December - January), GAT-520-79-87, Goodyear Atomic Corporation, Piketon, Ohio, February 1, 1980.